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IX. *On the Composition of Zeolite.* By James Smithson, Esq.  
F. R. S.

Read February 7, 1811.

MINERAL bodies being, in fact, *native chemical preparations*, perfectly analogous to those of the laboratory of art, it is only by chemical means, that their species can be ascertained with any degree of certainty, especially under all the variations of mechanical state and intimate admixture with each other, to which they are subject.

And accordingly, we see those methods which profess to supersede the necessity of chemistry in mineralogy, and to decide upon the species of it by other means than her's, yet bringing an unavoidable tribute of homage to her superior powers, by turning to her for a solution of the difficulties which continually arise to them, and to obtain firm grounds to relinquish or adopt the conclusions to which the principles they employ, lead them.

Zeolite and natrolite have been universally admitted to be species distinct from each other, from Mr. KLAPROTH having discovered a considerable quantity of soda and no lime, in the composition of the latter, while Mr. VAUQUELIN had not found any portion of either of the fixed alkalis, but a considerable one of lime, in his analysis of zeolite.\*

The natrolite has been lately met with under a regular

\* Journal des Mines, No. XLIV.

crystalline form, and this form appears to be perfectly similar to that of zeolite, but Mr. HAÜY has not judged himself warranted by this circumstance, to consider these two bodies as of the same species, because zeolite, he says, “does not contain an atom of soda.” \*

I had many years ago found soda in what I considered to be zeolites, which I had collected in the island of Staffa, having formed GLAUBER’S salt by treating them with sulphuric acid; and I have since repeatedly ascertained the presence of the same principle in similar stones from various other places; and Dr. HUTTON and Dr. KENNEDY, had likewise detected soda in bodies, to which they gave the name of zeolite.

There was, however, no certainty that the subjects of any of these experiments were of the same nature as what Mr. VAUQUELIN had examined, were of that species which Mr. HAÜY calls mesotype.

Mr. HAÜY was so obliging as to send me lately, some specimens of minerals. There happened to be amongst them a cluster of zeolite in rectangular tetrahedral prisms, terminated by obtuse tetrahedral pyramids whose faces coincided with those of the prism. These crystals were of a considerable size, and perfectly homogeneous, and labelled by himself “*Mesotype pyramidée du depart. du Puy de Dôme.*” I availed myself of this very favourable opportunity, to ascertain whether the mesotype of Mr. HAÜY and natroliite, did or did not differ in their composition, and the results of the experiments have been entirely unfavourable to their separation, as the following account of them will show.

10 grains of this zeolite being kept red hot for five minutes

\* Journal des Mines, No. CL. Juin 1810, p. 458.

lost 0.75 grains, and became opaque and friable. In a second experiment, 10 grains being exposed for 10 minutes to a stronger fire, lost 0.95 grains, and consolidated into a hard transparent state.

10 grains of this zeolite, which had not been heated, were reduced to a fine powder, and diluted muriatic acid poured upon it. On standing some hours, without any application of heat, the zeolite entirely dissolved, and some hours after, the solution became a jelly: this jelly was evaporated to a dry state, and then made red hot.

Water was repeatedly poured on to this ignited matter till nothing more could be extracted from it. This solution was gently evaporated to a dry state, and this residuum made slightly red hot. It then weighed 3.15 grains. It was *muriate of soda*.

The solution of this muriate of soda being tried with solutions of carbonate of ammonia and oxalic acid, did not afford the least precipitate, which would have happened had the zeolite contained any lime, as the muriate of lime\* would not have been decomposed by the ignition.

The remaining matter, from which this muriate of soda had been extracted, was repeatedly digested with marine acid, till all that was soluble was dissolved. What remained was silica, and, after being made red hot, weighed 4.9 grains.

The muriatic solution, which had been decanted off from the silica, was exhaled to a dry state, and the matter left made red hot. It was alumina.

\* These names are retained for the present, as being familiar, though, since Mr. DAVY's important discovery of the nature of what was called oxymuriatic acid, the substances to which they are applied, are known not to be salts, but metallic compounds analogous to oxides.

To discover whether any magnesia was contained amongst this alumina, it was dissolved in sulphuric acid, the solution evaporated to a dry state, and ignited. Water did extract some saline matter from this ignited alumina, but it had not at all the appearance of sulphate of magnesia, and proved to be some sulphate of alumina which had escaped decomposition, for on an addition of sulphate of ammonia to it, it produced crystals of compound sulphate of alumina and ammonia, in regular octahedrons.

This alum and alumina were again mixed and digested in ammonia, and the whole dried and made red hot. The alumina left, weighed 3.1 grains.

Being suspected to contain still some sulphuric acid, this alumina was dissolved in nitric acid, and an excess of acetate of barytes added. A precipitate of sulphate of barytes fell, which after beingedulcorated and made red hot, weighed 1.2 grains. If we admit  $\frac{1}{3}$  of sulphate of barytes to be sulphuric acid, the quantity of the alumina will be  $= 3.1 - 0.4 = 2.7$  grains.

From the experiments of Dr. MARCET,\* it appears that 3.15 grains of muriate of soda, afford 1.7 grains of soda.

Hence, according to the foregoing experiments, the 10 grains of zeolite analysed, consisted of

Silica	-	-	-	4.90
Alumina	-	-	-	2.70
Soda	-	-	-	1.70
Ice	-	-	-	0.95
				<hr/>
				10.25

\* Phil. Trans. 1807.

As these experiments had been undertaken more for the purpose of ascertaining the nature of the component parts of this zeolite than their proportions, the object of them was considered as accomplished, although perfect accuracy in the latter respect, had not been attained, and which, indeed, the analysis we possess of natrolite by the illustrious chemist of Berlin, renders unnecessary.

I am induced to prefer the name of zeolite for this species of stone, to any other name, from an unwillingness to obliterate entirely from the nomenclature of mineralogy, while arbitrary names are retained in it, all trace of one of the discoveries of the greatest mineralogist who has yet appeared; and which, at the time it was made, was considered as, and was, a very considerable one, being the first addition of an earthy species, made by scientific means, to those established immemorially by miners and lapidaries, and hence having, with tungstein and nickel, led the way to the great and brilliant extension which mineralogy has since received. And, of the several substances, which, from the state of science in his time, certain common qualities induced Baron CRONSTEDT to associate together under the name of zeolite; it is this which has been most immediately understood as such, and whose qualities have been assumed as the characteristic ones of the species.

Indeed, I think that the name imposed on a substance by the discoverer of it, ought to be held in some degree sacred, and not altered without the most urgent necessity for doing it. It is but a feeble and just retribution of respect for the service which he has rendered to science.

Professor STRUVE, of Lausanne, whose skill in mineralogy

is well known, having mentioned to me, in one of his letters, that from some experiments of his own, he was led to suspect the existence of phosphoric acid in several stones, and particularly in the zeolite of Auvergne, I have directed my enquiries to this point, but have not found the phosphoric, or any other acknowledged mineral acid, in this zeolite.

Many persons, from experiencing much difficulty in comprehending the combination together of the earths, have been led to suppose the existence of undiscovered acids in stony crystals. If quartz be itself considered as an acid, to which order of bodies its qualities much more nearly assimilate it, than to the earths, their composition becomes readily intelligible. They will then be neutral salts, silicates, either simple or compound. Zeolite will be a compound salt, a hydrated silicate of alumina and soda, and hence a compound of alumina not very dissimilar to alum. And topaz, whose singular ingredients, discovered by Mr. KLAPROTH, have called forth a query from the celebrated Mr. VAUQUELIN, with regard to the mode of their existence together,\* will be likewise a compound salt, consisting of silicate of alumina, and fluuate of alumina.

Our acquaintance with the composition of the several mineral substances, is yet far too inaccurate to render it possible to point out with any degree of certainty, the one of which zeolite is an hydrate, however the agreement of the two substances in the nature of their constituent parts, and in their being both electrical by heat, directs conjecture towards tourmaline.

*St. James's Place, Jan. 22, 1811.*

\* *Annales du Museum d'Hist. Nat. tome 6, p. 24.*

*Addition to the Account of native Minium.*

After I had communicated to the President, the account of the discovery of native minium, printed in the Philosophical Transactions for 1806, I learned that this ore came from the lead mines of Breytau in Westphalia.